Programming and Controlling of Danfoss TRV RA-Plus-w

The Danfoss Radiator Valve Control RA-Plus-w is a *Scheduled Setback Thermostat*. It turns from a manually pre-set comfort temperature into a energy saving setback temperature mode either triggered by a manual push of a button or by Z-Wave control or using a preset internal setback schedule. The programming of the switching sequences - 9 switching points for up to 7 different days – is done via Z-Wave as well. The setback temperature is about 4 degrees lower then the manually selected comfort temperature.

Certain Z-Wave Controllers support the RA plus-w (Merten CONNECT Funkzentrale, MiVasaVerde VERA, Homeseer HS2), however usually only the Z-Wave override function with direct control of the mode of the thermostat is used. The switching commands are triggered by timer functions within the controller itself.
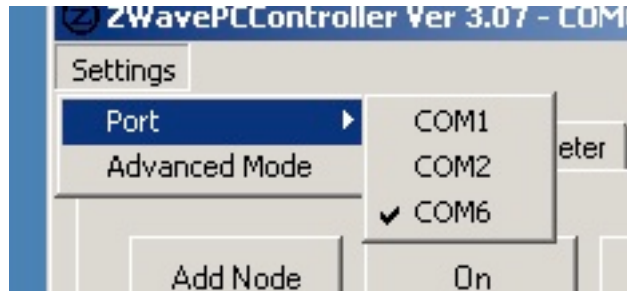
The software utility PC-Z-Controller supports both the direct control using override commands and the pre programming of timed switching events in the thermostat.
Up to 9 switching points (change of status between comfort and energy saving) for the 7 days of the week can be programmed into the device to enable running the energy saving function automatically without any further interaction or control by the Z-Wave controller.

The software is derived from a universal Z-Wave controller and therefore needs some further explanation. A Z-Wave PC interface such as a Seluxit USB Controller viaSens 100 is needed to operate the software.

The software starts like a typical windows application. The start of the software may take some seconds since the presence of a Z-Wave interface needs to be detected on the different interfaces of the PC. Once successfully initialized the software shows a main window.

Before using the software the serial port needs to be selected. The "settings" menu offers a dialog to choose the right serial interface. Since the Seluxit USB controller creates a virtual serial device the correct serial port is usually a number higher than 2 (COM 6 in the example shown below).
Beside the port selection the software can be turned into an *Advanced Mode* with many Z-wave specific functions. However this setting in only suited for professional users.

The main dialog window consists of two parts. The lower part shows a list of all Z-Wave devices already integrated in the network controlled by the Z-Wave interface used. If a brand new USB device is used this list should be empty and show the USB controller itself only.

Above the list of the devices there is a dialog with functions which are to be applied to the Z-Wave device choosen from the list.

Below the dialog field there is a status reporting line. A correct setup of the system is indicated here. If an error message is shown, there may be one of the following reasons:

- A wrong COM ports is used
- The Z-Wave device driver is not loaded correctly.
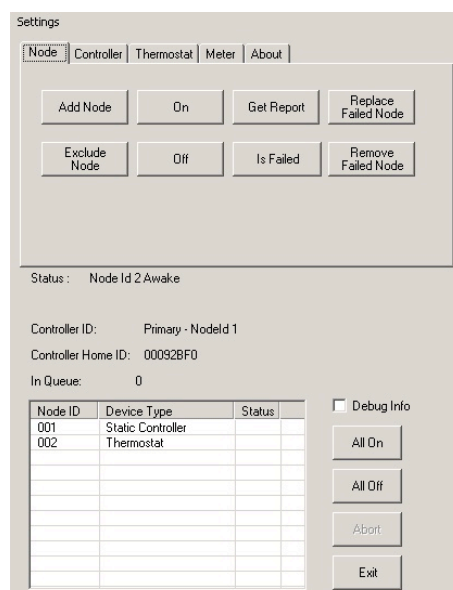- There is no Z-Wave device connected to the PC

For the control of the RA plus-w two of the control tabs are of particular interest:

The Node-Tab

The node tab allows to include or to exclude Z-Wave devices. After selecting the include or exclude function the inclusion/exclusion needs to be confirmed by three times pressing the button on the thermostat. If the inclusion/exclusion was successful a short confirmation message is shown on the status line.

The following two reasons may result in a failure to include the devices:

- Check, if the thermostat is powered correctly. This can be done by pressing the button on the thermostat and by checking if the red LED is on.
- Exclude the device using the process described above and try to include the device again. (3 times short tipping of the button)

All other switching functions of the Node-Tab are designed for the administration of the network and not needed for RA plus-w thermostats. Once all thermostats are included successfully switch over to the Thermostat-Tab.

The Thermostat-Tab

The *Thermostat* tab is divided into two functions. In order to use the function one thermostat needs to be selected from the list of available (and included) Z-wave devices. All functions apply to the selected device.

The battery control

The thermostat is a battery powered device and the battery live time is a very critical parameter of a device. In order to increase the battery life the thermostat will stay in a sleeping mode most of the time. The following events result in a wake-up of the device:
1. Pressing the button of the device
2. Reaching a time for switching the status of the device pre programmed in the device before.
3. The device will wake up regularly after a pre defined time to check if the controller has any commands for the device to be executed.

In the upper part of the tab the last wake up time and the next scheduled wake up time is shown. The wake up interval - the time between two scheduled wake ups – can be set.
Attention: A changed wakeup interval becomes valid AFTER the next wakeup.

If a command is issued to a specific thermostat, the thermostat will be most likely in sleeping state. This means that the command can not be delivered but will be queued. The software will report a failed transmission and the number of commands in the queue (shown as value as well) we increase.

Hint: During testing the short wake up interval is recommended to shorten test times. After the system is in place a rather long wakeup interval is recommended to increase battery life.

Beside the wakeup information the battery section of the thermostat control tab shows the actual charging status of the battery. This value is updated when the device wakes up.

Overwrite and Schedule

The typical mode of operation for the RA plus-w is to preset times when the status of the device switches from convenience to setback and vice versa. In parallel to this the current state can be overwritten by pressing the button on the device itself or by issuing a overwrite command which is executed immediately (means after the next wakeup). Both the overwrite command and the local button force the thermostat into the desired state overwriting the preset value. The overwrite status is active until it gets overwritten by the next scheduled change of status.

The dialog tabs shows if the thermostat uses the pre set schedule or is in overwrite state (sun symbol indicates convenience level, moon system indicates energy saving mode)

The lower part of the thermostat tab allows to pre set the switching per week day. The button "Change Schedule for" opens a dialog window which allows to set up to 9 changes of status per weekday.

Example for a pre set switching sequence:

Monday:

0:00	Setback
6:00	Comfort
8:00	Setback
16:00	Comfort
22:00	Setback

For the following day the unit is already in setback mode at 0:00, hence the first entry can be removed.

Battery Life time

The thermostat needs energy for two basic functions:
- Turning the motor to switch between the two states
- Send and receive wireless commands

It does not make any difference if the Thermostat is actively transmitting data or "only" listening for data to be received. In both cases the transceiver electronics is active and takes energy.
During the sleeping state the energy consumption is minimal. Hence, the thermostat should e in sleeping state most of the time and wakeup not often and for a short period of time only.

When the Thermostat wakes up it issued a wakeup notification to the controller of the Z-wave network. The controller will then send all queued commands and turn the device back into sleep mode right after sending the commands. If no command needs to be sent, the controller will turn the device in sleeping mode immediately after receiving a wakeup notification.

In case there is no active controller in the network (a PC is used as controller and is turned off) the thermostat will wake up, send a notification and will wait 60 seconds until turning back into sleep mode automatically. Unfortunately it will take about 0.5 mAh of energy during this time of wakeup, which reduced the battery life.

In order to reach the maximum battery life time of up to 4 years (using Alkaline battery with a capacity of 1600 mAh) there must be an active controller to turn the thermostat back into sleeping mode right after wake up. All Z-Wave controllers and software solutions support this function, however the recommended Seluxit controller controls the wakeup even if no PC software is running and the controller is not even connected to a USB Port of a PC. The Seluxit allows to be powered from a standard 5 V external power supply with minimal energy consumption.

If there is already a static Z-Wave controller in the network, which is active permanently, there is no need for any extra setup or equipment. Otherwise the use of a Seluxit controller is recommended even after the setup of the thermostats to enhance battery life.